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Physiographic Characteristics of Mose Watershed : a Part of Mutha River Basin, Pune Maharashtra

Pacharne Sunil.B.[1]Barakade Ankush. J[2,*]
[1]Research Student, Shivaji University, Kolhapur, Maharashtra, India, Department of Geography
[2]Research Guide, Head, Geography Department, Balwant College Vita, Sangali, Maharashtra, India
*Email ID : ankushbarakade@gmail.com

ABSTRACT
The Mose watershed physiographic characteristics, such as the watershed network, geometry, texture analysis, and relief characterization, are some elements affecting surface water and groundwater. The Mose watershed, which has share of the Mutha River basin in Maharashtra's Pune district, has been studied for its physiographic characteristics for whom ArcGIS software has been used to calculate the watershed area. The watershed's entire size is 133.67 square km., and its total length and width are 20.97 and 9.36 km, respectively as well as other streams' properties as well have been defined, like the watershed drainage density, it has 4.6, this is a high density in the research area. The length of overland flow and watershed density has inverse variation in study area, which at the Mose watershed has been computed to be 0.11. The frequency of streams is 8.01 sq. km, which is included among the high frequencies of streams categories which indicated increased runoff. The circulation ratio, elongation ratio, and form factor, which has found at 0.49 and 0.62, and 0.30 respectively, as well as these elements that defined the shape of the basin, is specify as in shape factors. These values indicate watershed is not in circular shape, so means there will have lower risk of flood. The basin shape which has elongated in shape as well as the watershed have high relief and steep slope. The Mose watershed studies have been attempted to an assessment of physiographic characteristics for different aspects of this work. This study describes most of the first stage of morphometric physiographic characteristics of this watershed, which will be essential for the watershed's hydro study and groundwater assessments in the future.
Keywords: *Watershed, Morphometric, Physiography, Groundwater, River Basin,*

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INTRODUCTION

The physiography generally expresses the natural physical features of the earth's surface as well as hydrological features this type of work we can attempt through morphometry and land use land cover, as well as both provide to us present or past geography and evolutionary history of any study region [1-3]. A morphometric investigation of a basin provided information on various features and characteristics [4,5]. Furthermore, the hydrological nature of the surface can be determined through morphometric assessment of the watershed as well as we can depict through the map for better understand the characteristics of the watershed, but in this study has attempted through morphometric physiography, it is a fundamental need of the physical propertiesof the earth surface to understanding the topographic future and their evolution is essential, so many researchers are used the traditional method to investigate the morphometric parameter like rotameter used to calculate area [6,7], but recently this technique is apart from new GIS technique for accurate investigation of historyand present of the topography as well as the morphometric study of the drainage basin provides information on the basin's stream character, geological structure, and history [8-10]. However, the key elements affecting surface runoff are geology, slope, and climate; these surface runoffs also affect groundwater potential and quality. In this research work, all morphometric aspects have attempted to describe and investigate the physiography of the Mose watershed.

STUDY AREA

The Mose River originates in the Sahyadri range of 940 m height above mean sea level and follows a route that runs from northwest to southeast. It is a tributary of the Mutha river that connect to the Ambi river near the villages of KuranKhurd and KuranBudruk. The area of the watershed is 133.67 km/sq., the

watershed length and width are 20.97 km and 9.37 km, respectively. Varasgaon is the name of a village as well as a dam on the Mose River, which provides water to Pune city, while Veer BajiPasalkar Dam is another name for it. The Veer BajiPasalkar was born in this watershed of the Mose, which was the Commander under the Maratha Empire [11,12]. The study region is located between the latitudes of 18° 20' N and 18° 25' N, and the longitudes of 73° 25' E and 73° 37' E. Mose has a dendritic drainage pattern. The Pune's climate is hot and semi-arid, mostly during the monsoon season, rice and vegetable crops growing in the study area. Most of the watershed's upper part is mountainous, and teak, bamboo, Acacia, and mangoes trees are present in the study area.

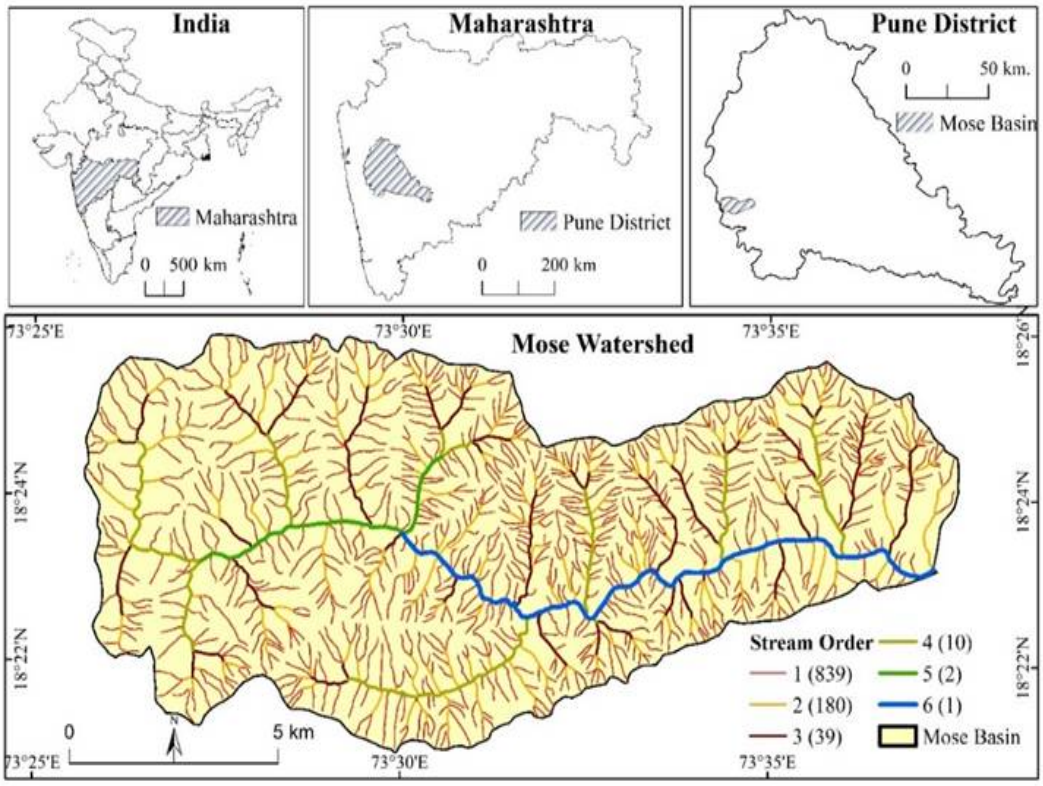

Figure 1: Study Area map of the Mose Watershed.

MATERIAL AND METHODS

Strahler's stream ordering method has been used for this research work as well as GIS tools has used to investigate the morphometric parameter of the Mose watershed. The Survey of India toposheets numbers like 47 F/7 and 47 F/11 on a scale of 1:50000 scale have been used for study area, as well as geomorphic parameters that have been analysed and computed with the help of standard formulas that have been shown in Table No. 1, and some morphometric parameters such as basin perimeter, drainage area, the longest flow path, basin length, and basin width have been computed with the help of ArcGIS 10.8 software. Thematic mapshave been prepared using ArcGIS software for the purpose of the study and to depict physiographic aspects [12-14].

Morphometry

The measuring and mathematical analysis of the configuration of the earth's surface, shape, and dimensions of its landforms are referred to as morphometry. The main characteristics of a river basin as evaluated by several morphometric parameters and assessment of these morphometric parameters is a better way to understand the physiography of the surface topography, many scholars have divided morphometric parameters into different aspect like Linear aspect, Arial aspect, and Relief aspect.

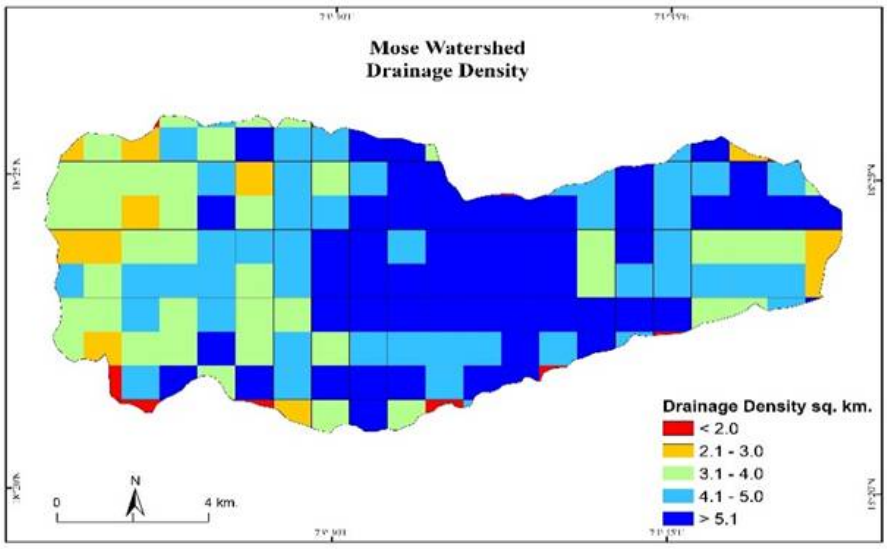

Fig. 2 Drainage Density of Mose Watershed

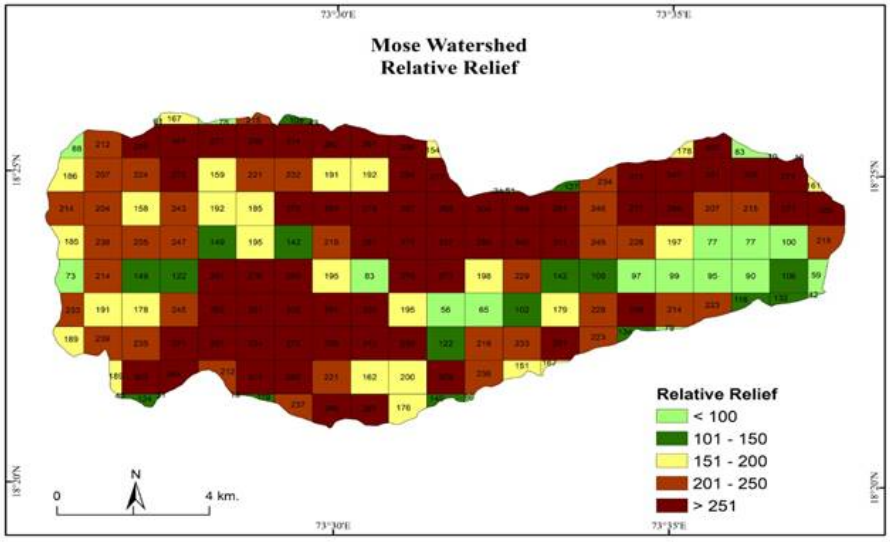

Fig. 3 Relative relief of Mose watershed

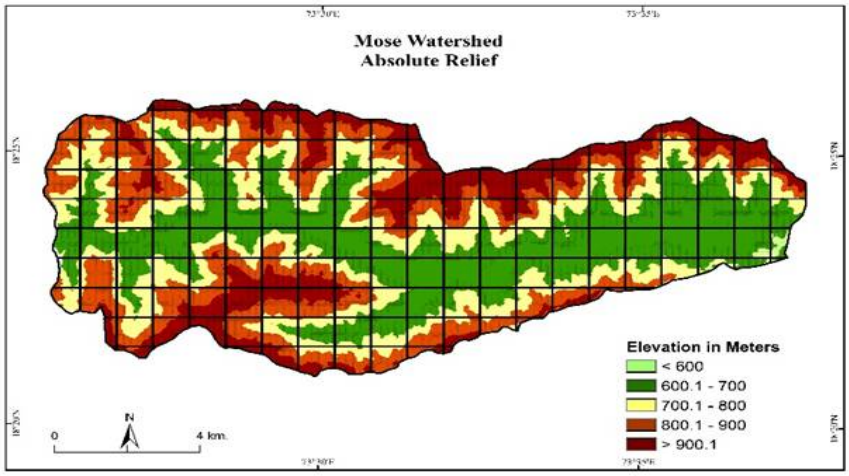

Fig. 4 Absolute Relief of the Mose watershed

Sr. No	Parameters	Formula	Reference
	Parameters of the Watershed Network		
1	Order of Stream	Hierarchical rank	Strahler (1952)
2	Total Stream order	Sum of stream order	
3	Stream length (Lu) (km)	Length of the stream	Strahler (1964)
4	Stream Number (Nu)	Nu=N1+N2+.... +Nn	Horton (1945)
5	Ratio of Stream length (Lur)	Lur = Lu/Lu 1 Lu = The total stream length of the order 'u' Lu 1 = The total stream length of its next lower order	Strahler (1964)
6	Bifurcation ratio (Rb)	Rb=Nu/Nu+1 Nu =Total no. of stream segments of order 'u' Nu+1= Number of stream segments of the next higher order	Strahler (1964)
7	Mean Stream length (Lum)	Lum = Lu/Nu Lu=The total stream length of order 'u' Nu=Total no. of stream segment of order 'u'	Horton (1945)
	Parameters of the Watershed Geometry		
8	Perimeter of the Basin (P)	GIS software	Schumm (1956)
9	Length of the Basin (Lb) (km)	GIS software	Schumm (1956)
10	Area of the Basin (A) (sq.km.)	GIS software	Schumm (1956)
11	Basin Width	GIS software	
12	Form factor (Rf)	Rf =A/Lb² A= Area of the basin ((km²)), = Lb² Square of basin length	Horton (1932)
13	Ratio of Elongation (Re)	= $2\sqrt{(A/\pi)}$ Lb A = Area of the basin (km²) π = 3.14 Lb = Basin length	Schumm (1956)
14	Ratio of Circularity (Rcn)	Rcn = A/P A = Area of the basin (km²) P = Perimeter	Strahler (1964)
	Parameters of the Watershed Texture		
15	Length of overland flow (Lo)	Lo = 1/Dd * 2 Dd = Drainage density	Horton (1945)
16	Density of Drainage (Dd)	(Dd) = Lu/A Lu = The total stream length of basin A = Area of the basin ((km²))	Horton (1932)
17	Frequency of the Stream (Fs)	Fs = Nu/A Nu = Stream Number A = Area of the basin ((km²))	Horton (1932)
	Parameters of the Relief Characteristics		
18	Maximum Basin Height(Z) (m)	GIS software	
19	Minimum Basin Height(z) (m)	GIS software	
20	Total Basin relief (H) (m)	H = Z - z	
21	Ratio of Relief (Rhl)	Rhl = H/Lb H = basin relief Lb = basin length straight parallel to main drainage	Schumm (1956)
22	Ruggedness Number (Rn)	Rn = Dd * (H/1000)	Strahler (1968)

Table1 (Source-ESRI India User Conference 2017, 18, 1–10.)

RESULTS AND DISCUSSION

Table 2: Parameters of the Watershed Network

Sr. No.	Parameter	Computed value						Total
1	Order of Stream	1	2	3	4	5	6	21
2	Streams Number (Nu)	839	180	39	10	2	1	1071
3	Stream Length (Lu)	435.98	82.12	44.69	24.95	7.32	15.57	610.63
4	Mean stream length (Lum)	0.52	0.46	1.14	2.49	3.66	15.57	---
5	Ratio of Stream Length (Lur)	---	0.19	0.54	0.56	0.29	2.13	μ 0.74
6	Bifurcation Ratio (Rb)	4.66	4.61	3.9	5	2	---	μ 4.03

(Source-Computed by Researcher)

Order of Stream

The first step in assessing the drainage basin is to look at the stream orders. Stream order has carried out in the current investigation based on Table No. 2 lists all of the orders and stream numbers. Six order stream is the highest stream in the Mose watershed.

Number of Streams(Nu)

The counted streams of each channel are termed as the stream number according to [4] of stream numbers, as per the given table observation, The number of streams is declining while the stream order is increasing. There are 1071 streams in total. Stream Length (Lu)

Moseriver's Stream length has measured from source to drainage Confluence. The first order is 435.98 km, while the second, third, fourth, fifth, and sixth orders are 82.12 km, 44.69 km, 24.95 km, 7.32 km, and 15.57 km long, respectively. In first-order streams, the overall length of stream sections is typically the longest, and it decreases as the stream order changes.

Mean Stream Length (Lum)

It's related to basin surface characteristics and it's computed by dividing the order's total stream length (u) by the number of stream segments. According to the Table No 2 observations, the mean stream length is increasing as per the stream order increases.

Ratio of Stream Length (Lur)

The stream length ratio is the proportion of a particular order's stream length to the next lower order's stream length (Strahler, 1964). The ratio has been indicating variations in surface topography and slope, although the upper part of the watershed has seen a low value in table No 2 that indicates the highest slope, while the lower part of the watershed has seen a high value that indicates the lowest slope.

Bifurcation Ratio (Rb)

A bifurcation ratio larger than 5 implies that the growth of a drainage network layout is structurally controlled (Strahler, 1957) for the entire basin. The bifurcation ratio has found 4.03 in general; these values are seen in places where geologic formations do not have a significant impact on drainage patterns.

Table 3: Parameters of the Watershed Geometry

Sr.No.	Parameter	Computed value
1	Perimeter of the Basin (P) (km)	58.33
2	length of the basin (Lb)	20.97
3	Area of the Basin (A) (sq.km)	133.67
4	Form factor (Rf)	0.30
5	Ratio of elongation (Re)	0.62
6	Ratio of Circulatory (Rcn)	0.49
7	Basin Width (km)	9.36

(Source-Computed by Researcher

Perimeter of the Basin (P)

The complete outside margin or fringe of the watershed is known as the basin perimeter. The watershed has a perimeter of 58.33 km, it calculated using ArcGIS software.

length of the basin (Lb)

The watershed's maximum length is 20.97 km. The Mose River is > 14 km from the watershed's beginning to the confluence's endpoint, which indicates that it is longer, and this measurement is vital in determining the structure and topography of the basin.

Area of the Basin (A)

The basin area is defined as the Whole area of basin, and it has been calculated using ArcGIS software. The total size of the watershed is 133.67 sq.km, and it is a component of the Mutha river basin.

Form Factor (Rf)

In Table No 2 shows that the Rf computed for this watershed is 0.30. This value represents the watershed's elongated geometry. Flood flows in such elongated basins are easier to manage than those in circular basins.

Ratio of elongation (Re)

The study area's examination reveals that the elongation ratio is 0.62, which reflects the basin's elongated shape, which includes high relief and steep slopes.

Ratio Circulatory (Rcn)

The circulatory ratio typically ranges from 0 to 1. It's required for flood risk assessment. If the value is higher, there is a greater possibility of more flow and higher flood risk. The circulatory ratio in the examined area is 0.49, indicating that the watershed is not circular and thus less prone to flood.

Table 4: Watershed Texture Parameters

Sr.No.	Parameters	Computed value
1	Density of drainage (Dd) sq.km	4.06
2	Frequency of the stream (Fs) sq.km	8.01
3	Length of overland flow (Lo)	0.11

(Source-Computed by Researcher)

Density of drainage (Dd)

The drainage density in the study area is 4.06, which shows weak or impermeable underlying material, scant vegetation, and a steep relief. The drainage density is an important characteristic of a drainage basin because it controls the texture of drainage systems [3]. According to [1], drainage density is split into four classes: low 2, moderate 2 – 4, high 4 – 6, and very high > 6, and the drainage density of the study area 4.6 falls into the high drainage density group.

Frequency of the stream (Fs)

Stream frequency values are used to classify basins as low 2.5, moderate 2.6 to 3.5, or high >3.5. The research area stream frequency is 8.01 sq.km, and it ranges from high stream frequency that indicates more runoff.

Length of Overland Flow (Lo)

Lower values suggest greater relief, whereas larger values indicate less relief. The research area's length of overland flow is 0.11, indicating that the watershed has high relief.

Table 5: Parameters of the Relief Characteristics

Sr. No.	Parameters	Computed value
1	Maximum Basin Height (Z) (m)	1120
2	Minimum Basin Height (z) (m)	580
3	Total Basin relief (H) (m)	540
4	Ratio of Relief (Rh) m/km	25.75
5	Ruggedness number (Rn)	2.47

(Source-Computed by Researcher)

Total Basin Relief (H)

Total basin relief is also known as relative relief. It is estimated between the highest point and lowest point differences, it is 540 m in the study area. [7] state that the estimated value of classification is divided into three categories: less than 500, 500 to 850, and > 850.According to this categorization, the study area falls into the moderate category, which suggests that the study area's potential energy, denudation rate, sediment transportation, and discharge rate are all moderate.

Absolute Relief

This absolute relief specify that the exact value of the elevation from mean sea level which is found in the study area 1120 m. near the Themghar and the lowest elevation found near the water shed is 580 m.

Ratio of Relief (Rh)

The relief ratio is the proportion of the basin's overall relief to its longest dimension parallel to the main drainage line. The higher the value, the steeper the slope and the greater the relief, whereas the lower the value, the lower the slope and the lower the relief. The calculated value for the Mose watershed is 25.75 m/km, which indicates that the watershed has a steep slope and high relief.

Ruggedness Number (Rn)

Ruggedness, this number represents the correlation between watershed relief and drainage density. The drainage density and basin relief are combined to form Rn. The result of the calculation is 2.47, but this value is high, indicating high relief and drainage density.

CONCLUSION

The watershed's various morphometric parameters are the most accurate calculation of the physiography. This research work has been carried out in different aspects like watershed network, watershed geometry, watershed texture parameter, and relief characterization of the watershed. The physiographic attributes of the watershed are described by the different morphometric parameters. Theseattributes we can utilised to interpret the watershed's geology and hydrologic settings as well as watershed network parameters has a direct link with water flow and erosion, however, if value is high if so, more the erosion similarly, the watershed geometry parameter like Rf, Re, Rcn has an inverse bond with runoff and erosion. if value is low if so, greater the erosions. vice versa Whereas the use of morphometric parameters and thematic maps, this paper explains the hydro physiography of the research area and provides information on the ground scenario. The absolute relief map depicts the overall condition of elevation in the watershed, while the relative relief or basin map depicts the optimum relief in the research region. Watersheds are divided into circular and elongated types based on their shape. The watershed in the research region is elongated in shape that means high relief and first stage of morphometry. If the watershed is circular, it has low relief and is in a second stage of geomorphometry. As pertable computed values the Mose watershed is elongated shape and it is first stage of morphometry means youthful stage of river which characterise by high drainage density, stream frequency, high relief, steep slope, and high runoff etc.

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